



A Potent Vector

Assessing Chinese Cruise Missile Developments

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The numerous, increasingly advanced cruise missiles being developed and deployed by the People's Republic of China (PRC) have largely flown under the public's radar. This article surveys PRC cruise missile programs and assesses their implications for broader People's Liberation Army (PLA) capabilities, especially in a Taiwan scenario.

This article draws on findings from a multiyear comprehensive study of Chinese cruise missiles based exclusively on open sources. More than 1,000 discrete Chinese-language sources were considered; several hundred have been incorporated in some form. In descending level of demonstrated authority, these Chinese sources include PLA doctrinal publications (for example, *Science of*

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Campaigns) describing how cruise missiles might be used in operational scenarios; specialized technical analyses (*Winged Missiles Journal*) from civilian and military institutes detailing many specific aspects of such weapons and their supporting infrastructure; didactic PLA discussions (*Modern Navy* and *People's Navy*); generalist deliberations on the development trajectory and operational use of cruise missiles (*Naval and Merchant Ships* and *Modern Ships*); and unattributed speculation on a variety of Web sites. To be accessible to a general audience, this article includes only a fraction of the several hundred citations found in the full study, together with several related sources.

These Chinese sources were supplemented with a wide variety of English-language sources, including—in descending level of demonstrated authority—U.S. Government reports, analyses by scholars and think tanks, and online databases. The authors drew on their combined technical, arms control, and Chinese analysis experience to compare and assess information for reliability.

The result is a study whose details must be treated with caution, but whose larger findings are likely to hold.

Overview

China's military modernization is focused on building modern ground, naval, air, and missile forces capable of fighting and winning local wars under "informatized conditions." The principal planning scenario has been a military campaign against Taiwan, which would require the PLA to deter or defeat U.S. intervention. Beijing is now broadening this focus to its Near Seas (Yellow, East, and South China seas) more generally.

The PLA has sought to acquire asymmetric "assassin's mace" technologies and systems to overcome a superior adversary and couple them to the command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) systems necessary for swift and precise execution of short-duration, high-intensity wars.

A key element of the PLA's investment in antiaccess/area-denial (A2/

AD) capabilities is the development and deployment of large numbers of highly accurate antiship cruise missiles (ASCMs) and land-attack cruise missiles (LACMs) on a range of ground, naval, and air platforms. China's growing arsenal of cruise missiles and the delivery platforms and C4ISR systems necessary to employ them pose new defense and nonproliferation challenges for the United States and its regional partners.

Military Value

Chinese writers rightly recognize cruise missiles' numerous advantages. Cruise missiles are versatile military tools due to their potential use for precision conventional strike missions and wide range of employment options. Although China appears heavily focused on precision conventional delivery, cruise missiles could also be employed to deliver nuclear, biological, or chemical weapons. Due to their superior aerodynamic flight stability compared to ballistic missiles, cruise missiles—by conservative estimates—enlarge the lethal area for biological attacks by a factor of 10.

Modern cruise missiles offer land, sea, and air launch options, allowing a "two-stage" form of delivery that extends the already substantial range of the missiles themselves. They may also be placed in canisters for extended deployments in harsh environments. Because cruise missiles are compact and have limited support requirements, ground-based platforms can be highly mobile, contributing to prelaunch survivability. Moreover, cruise missiles need only rudimentary launch-pad stability, enabling shoot-and-scoot tactics.

Since cruise missile engines or motors do not produce prominent infrared signatures on launch, they are not believed to be detectable by existing space-warning systems, reducing their vulnerability to post-launch counterforce attacks. The potential combination of supersonic speed, small radar signature, and very low altitude flight profile enables cruise missiles to stress naval- and ground-based air defense systems as well as airborne surveillance and tracking radars, increasing the likelihood that they will successfully

penetrate defenses.¹ Employed in salvos, perhaps in tandem with ballistic missiles, cruise missiles could saturate defenses with large numbers of missiles arriving at a specific target within a short time.

At the same time, optimal employment of cruise missiles imposes significant requirements: accurate and timely intelligence, suitable and ideally stealthy and survivable delivery platforms, mission planning technology, command, control, and communications systems, and damage assessment. China has lagged in these areas, but its experts recognize their importance, and the relevant Chinese organizations are working hard to make progress.

Institutional and Organizational Actors

China began introducing ASCMs into its inventory in the late 1950s. The Fifth Academy under China's Ministry of National Defense was assigned the lead role in coordinating national efforts in ASCM research, design, and licensed production. Established in 1956 with U.S.-trained scientist Qian Xuesen as its first director, the Fifth Academy was instrumental in China's cruise missile development. Acting on guidance from the Central Military Commission, in 1958 the PLA Navy (PLAN) headquarters built an ASCM test site at Liaoxi, Liaoning Province.

Following several bilateral agreements, the Soviet Union transferred Type 542 KS-1 Komet (North Atlantic Treaty Organization [NATO] designation: SSC-2A Salish) shore-to-ship and Type 544 P-15 Termit (NATO designation: SS-N-2A Styx) antiship missiles, models, and technical data to China beginning in 1959. Moscow was to assist Beijing with these and other missile programs. The P-15 would provide the basic foundation for China's future development of more advanced ASCMs and eventually LACMs.

In 1960, Nanchang Aircraft Manufacturing Company established an assembly line to initiate ASCM production; it would later produce Shangyou-, Haiying-, and Yingji-series ASCMs. Despite the departure of Soviet advisors

in September 1960, China conducted its first successful missile test that November. In 1964, China's first ASCM, a license-produced version of the P-15, passed factory tests. The following year, its first flight test was successful. In late 1967, the resulting "Shangyou-1" missile was approved for production, and it entered service in the late 1960s.²

As part of China's efforts to develop an indigenous defense industry base, cruise missile programs received high-level political support from the beginning. In 1969, Zhou Enlai reportedly approved the establishment of a Military Industry Enterprise Base to produce ASCMs. Top leaders allocated funding and human capital and helped protect programs from political interference during the Cultural Revolution.

Yet this support has an important caveat: political leaders placed the highest priority on nuclear and ballistic missile programs given their strategic deterrence function. Cruise missiles, while prioritized more highly than aircraft and some other armaments, suffered from their logical application as armaments for the air force and navy and were subordinated to ground forces. Moreover, as the early Nanchang connection indicates, ASCMs were initially developed within China's aviation industry. This fact, and the industry's connection to a politically suspect PLA Air Force (PLAAF), imposed significant limitations.

Cruise missile programs therefore encountered more problems and registered slower progress than their ballistic missile counterparts. Not until the late 1960s and early 1970s was China able to produce its own modified derivatives of early Soviet-model cruise missiles. While recent years have witnessed remarkable progress in ASCMs such as the YJ-62 and LACMs such as the YJ-63/AKD-63 and DH-10, China continues to rely on foreign technological support—particularly Russian and Ukrainian design assistance.

To address persistent problems in its defense research, development, and acquisition system, China has converted numbered ministries to corporations, encouraged competition (with mixed results), and separated military

requirements and evaluations (General Armaments Department) from civilian defense industry management and production (formerly the Commission of Science, Technology, and Industry for National Defense, now the State Administration for Science, Technology, and Industry for National Defense). China has simultaneously worked to maximize access to foreign technology and employs an extensive bureaucracy to facilitate its transfer (very effectively) and absorption (less effectively).

China's cruise missile design, research, development, and manufacturing are now concentrated in a single business division within one of two state aerospace conglomerates, the China Aerospace Science and Industry Corporation (CASIC) Third Academy. One of seven design academies under CASIC—which has over 100,000 employees—the Third Academy is China's principal research and development (R&D) and manufacturing entity for cruise missiles; all others are secondary. Established in 1961, the Third Academy has been involved in the design and development of 20 types of cruise missiles, including the indigenous Haiying- and Yingji-series and their export versions.³ Today, it boasts 10 research institutes and 2 factories, with over 13,000 employees, including 2,000 researchers and around 6,000 technicians.

China's aviation industry remains involved in cruise missile R&D and production. Hongdu Aviation Industry Group (formerly Nanchang Aircraft Manufacturing Company), under Aviation Industry Corporation of China, produced Feilong-series cruise missiles for export.⁴

Finally, for three decades China has marketed a wide range of indigenously produced cruise missiles (and other weapons systems) through China Precision Machinery Import and Export Corporation (CPMIEC), the CASIC Third Academy's export management branch. Established in 1980, CPMIEC is a member of the Xinshidai Group and jointly owned by CASIC and the Chinese Aerospace Science and Technical Corporation.

Antiship Cruise Missile Developments

Like other nations, China has come to regard ASCMs as an increasingly potent means of shaping the outcome of military conflicts and thereby also strengthening peacetime deterrence. China has developed its own advanced, highly capable ASCMs (the YJ series) while also importing Russian supersonic ASCMs, which have no operational Western equivalents. (See table 1 for a list of Chinese ASCMs.)

China's most sophisticated and threatening imported Russian ASCMs include the 3M80E and 3M80MVE Moskit (NATO designation: SS-N-22 Sunburn) and the 3M54E Klub (NATO designation: SS-N-27B Sizzler). China's *Sovremenny*-class destroyers (Project 956E and 956EM) boast the supersonic Sunburn ASCMs that were first delivered to China in 2000–2001. The Project 956E ships carry the early 3M80E missile with a range of 120 kilometers (km), while the Project 956EM destroyers have the 3M80MVE that has an optional longer range (240 km) through the incorporation of a second, high-altitude flight profile setting. But this longer range comes at a price, as a 3M80MVE missile using the higher altitude profile would be detectable at much greater distances and thus more vulnerable to attacks from advanced air defense systems, such as Aegis. Both missiles execute sea-skimming attacks at an altitude of 7 meters and perform terminal maneuvers to reduce the target's point defense systems effectiveness. The Sunburn is reported to have a speed of Mach 2.3 and has a 300-kilogram (kg) semi-armor piercing warhead.⁵

Eight of China's *Kilo*-class submarines are Project 636M variants fitted with the Klub-S missile system, which includes the 3M54E/SS-N-27B Sizzler ASCM—also known earlier as Novator Alpha. This missile is unique in that it combines a subsonic, low-altitude approach with a supersonic terminal attack conducted by a separating sprint vehicle. The 3M54E's cruise range is 200 km at a speed of Mach 0.6–0.8. This is followed by the release of a solid-rocket-propelled,

sea-skimming sprint vehicle that travels the last 20 km to the target at a speed of Mach 2.9. The 3M54E ASCM has a 200-kg semi-armor-piercing warhead.

As in so many other areas, even as China seeks the best foreign systems available, it continues to develop increasingly capable indigenous systems. Of China's foremost indigenous ASCMs, the YJ-82 and YJ-83/83K are the most widely deployed, while the YJ-62 is among the most advanced. The YJ-82 is a solid-rocket-propelled, submarine-launched missile contained in a buoyant launch canister that is, for all intents and purposes, identical to the U.S. submarine-launched Harpoon. While credited with a range of 42 km, the lack of a solid-rocket booster, as with the surface-ship-launched YJ-8/8A, strongly suggests that the YJ-82's range will be shorter. The missile has a speed of Mach 0.9 and a terminal sea-skimming attack altitude of 5 to 7 meters, and it carries a 165-kg high-explosive fragmenting warhead.⁶

The YJ-83/83K missile represents an evolutionary improvement over the YJ-8/8A and the exported C802. Entering service with the PLAN in 1998–1999, the YJ-83 missile has the same propulsion system as the export C802 missile but uses an indigenous CTJ-2 turbojet instead of the French-made TRI 60-2. By replacing the bulky electronics and inertial reference unit (IRU) of the YJ-8/8A/C802 with digital microprocessors and a strap-down IRU, additional volume was made available to increase the YJ-83's range to 180 km at a speed of Mach 0.9. The air-launched YJ-83K has a rated range of 250 km at the same speed. Both the YJ-83 and 83K possess a slightly larger high-explosive fragmenting warhead of 190 kg. The YJ-83 is the main ASCM of the PLAN and is currently outfitted on virtually every surface combatant in active service. The YJ-83K can be carried by large and small aircraft alike and has been seen on JH-7/A fighter-bombers and H-6 bombers. The export variant of the YJ-83/83K is the C802A and the air-launched C802AK.⁷

In September 2005, China unveiled the C602 ASCM for the first time. The

Table 1. PLA Antiship Cruise Missiles (Major Systems)

Type	Manufacturer	Launch Platform	Range (km)	Payload (kg)	Speed	Guidance (inertial/terminal)
YJ-7 (C-701)	CASIC Third Academy	Ground, ship, air	25	30.5	Subsonic	Electro-optical/active radar
YJ-62 (C-602) and YJ-62A	CASIC Third Academy	Ship— <i>Luyang II</i> , ground	280–400 (YJ-62A)	210	Subsonic	Inertial/active terminal guidance
YJ-8 series (CSS-N-4 Sardine/C-801)	CASIC Third Academy	Ship, submarine, (YJ-82), air (YJ-81)	42	165	Subsonic	Inertial/active terminal guidance
YJ-83 (CSS-N-8 Saccade/C-802) multiple variants	CASIC Third Academy	Ship, ground, air	120 (ground/ship), 130 (air)	165	Subsonic	Inertial/active radar
YJ-83A/J (C-802A) multiple variants	CASIC Third Academy	Ship, submarine (?), ground, air	180 (ground/ship), 250 (air)	165	Subsonic	Inertial/active radar
YJ-91/KR-1 (Kh-31P)	Zvezda-Strela, Russia; indigenized by China	Ship, air (PLAAF/PLAN)	15–110	87–90 kg HE blast/fragmentation	Supersonic	Passive/Anti-radiation
AS-13 Kingbolt (Kh-59MK)	Raduga, Russia	PLAAF Su-30MKK	45–115	320 kg AP HE or 280 kg cluster	Subsonic	Inertial and TV/electro-optical
SS-N-22/Sunburn 3M80E Moskit; 3M80MVE (improved variant)	Raduga (Russia)	Ship; Project 956 <i>Sovremenny</i> destroyers; 3M80MVE on Project 956EM <i>Sovremenny</i> destroyers	120–240 (3M80MVE)	300	Supersonic	inertial/active/passive
SS-N-27B/Sizzler	Novator (Russia)	Submarine— <i>Kilo</i> Project 636M	200	200	Supersonic	INS/active
CH-SS-NX-13		Submarine— <i>Song, Yuan, Shang</i> , to be deployed on <i>Tang</i>	?	?	?	?

Source: Dennis M. Gormley, Andrew S. Erickson, and Jingdong Yuan, *A Low-Visibility Force Multiplier: Assessing China's Cruise Missile Ambitions* (Washington, DC: NDU Press, 2014), 18–19.

small-scale model was clearly larger than the one of the C802 nearby, and the system brochure boasted of a longer range (280 km), global positioning system (GPS) guidance—an unprecedented claim—and a larger semi-armor-piercing warhead (300 kg). The missile size was roughly consistent with large round launch canisters that had started showing up on coastal defense test sites and the Type 052C destroyers then under construction in 2004. The indigenous YJ-62 is very similar to the YJ-83 technologically and largely reflects an evolutionary change in size. While many

journals, articles, and Web sites quote the YJ-62's range as 280 km, this value is only appropriate to the export C602. China has limited the range of its export cruise missiles in conformance with the Missile Technology Control Regime restrictions of 300 km. The YJ-62 itself has a true range on the order of 400 kms. The long range likely necessitated the need for satellite navigation, and the YJ-62 is described as having the ability to use both GPS and Beidou constellations. The missile's speed is between Mach 0.6 and 0.8, and it executes a sea-skimming terminal attack at 7 to 10 meters. With

Table 2. PLA Land-attack Cruise Missiles

Type	Manufacturer	Launch Platform	Range (km)	Payload (kg)	Speed	Guidance
YJ-63/KD-63	CASIC Third Academy/CHETA	Air (H-6H and H-6K bomber)	200	500	Subsonic	INS/(?)/Passive Electro-optical terminal guidance
DH-10/CJ-10	CASIC Third Academy/CHETA	Ship, ground (3 canister on TELs)	1,500+	500	Subsonic	INS/Sat/TERCOM/Probable DSMAC for terminal guidance
KD-88	CASIC Third Academy/CHETA	Air	180–200	165	Subsonic	Inertial; active terminal guidance
KD-20/YJ-100	CASIC Third Academy/CHETA	Air	1,500–2,000	500	Subsonic	INS/Sat/TERCOM
Possible DH-2000	CASIC Third Academy/CHETA	Submarine	?	500	Subsonic	?
YJ-91/KR-1 (Kh-31P)	Zvezda-Strela, Russia; license-produced by China	Air (PLAAF/PLAN)	15–110	87–90 kg HE blast/fragmentation	Supersonic	Passive/Antiradiation
AS-13 Kingbolt (Kh-59MK)	Raduga, Russia	PLAAF Su-30MKK	115	320 kg AP HE or 280 kg cluster	Subsonic	Inertial and TV/electro-optical

Source: Gormley, Erickson, and Yuan, 25–26.

the exception of the Type 052C destroyers, the YJ-62 is only deployed in mobile coastal defense batteries.⁸

Finally, China has been working diligently on producing its own supersonic cruise missiles after the failed YJ-1/C101 and HY-3/C301. Both the YJ-12 and YJ-18 are undergoing tests and represent the next phase in China's ASCM capabilities. The YJ-12 appears to be a considerably lengthened Russian Kh-31-type missile and is speculated to have a range of 250 km and a speed of Mach 2.5. The YJ-12 is probably an aircraft-carried weapon only. Thus far, only certain H-6 bombers have been seen with a long pylon necessary to support a large missile with an integrated ramjet/booster propulsion system.⁹

The YJ-18 appears to be a Chinese copy of the 3M54E Klub. This missile has been described as having a cruise range of 180 km at Mach 0.8 and a sprint range of 40 km at Mach 2.5 to 3.0. It has been reported to be submarine torpedo tube-capable, which is consistent with

the CH-SS-NX-13 missile discussion in the Department of Defense's 2010 and 2011 annual reports to Congress. The YJ-18 has also been characterized as being able to be launched from a surface ship's vertical launching system (VLS), which is consistent with the capabilities of the generalized or universal VLS being fitted to the new Type 052D destroyer.¹⁰

Along with the growing improvements in ASCM performance, the PLAN has begun to expand its training and has become more diverse and realistic in recent years with increasing focus on cruise missile operations. Beijing has furnished its ASCMs with improved guidance and has started to implement satellite navigation capabilities. Most of the PLAN warships now have a dedicated over-the-horizon (OTH) targeting system, either the Russian-supplied Mineral-ME, or the indigenous version. Still, OTH targeting remains a challenge.

Chinese researchers are studying how to best overcome Aegis defenses and target adversary vulnerabilities. ASCMs

are increasingly poised to challenge U.S. surface vessels, especially in situations where the quantity of missiles fired can overwhelm Aegis air defense systems through saturation and multi-axis tactics. More advanced future Chinese aircraft carriers might be used to bring ASCM- and LACM-capable aircraft within range of U.S. targets.

A consistent theme in Chinese writings is that China's own ships and other platforms are themselves vulnerable to cruise missile attack. But China appears to believe it can compensate by further developing its capacity to threaten enemy warships with large volumes of fire.

Land-Attack Cruise Missile Developments

China has deployed two subsonic LACMs, the air-launched YJ-63/AKD-63 with a range of 200 km and the 1,500+ km-range ground-launched DH-10. (See table 2 for a list of Chinese LACMs.) Both systems benefited from ample technical assistance from foreign sources, primarily the Soviet Union/Russia. The first-generation YJ-63 is an air-launched LACM that employs an electro-optical (EO) seeker with man-in-the-loop steering via a command data link. This missile reportedly reached initial operating capability in 2004, was first seen in 2005 in Internet photography, and is right at the cusp as to when China incorporated satellite navigation in some of their weapons systems. It is currently unknown if the YJ-63/AKD-63 has this ability.¹¹ In addition to the YJ-63, two other LACMs use some sort of a command data link to feed back the data gathered from the EO sensor: the YJ-83KH and the K/AKD-88.¹² The second-generation DH-10 has a satellite navigation/inertial guidance system, but may also use terrain contour mapping for redundant midcourse guidance and a digital scene-matching sensor to permit an accuracy of 10 meters. Development of China's *Beidou/Compass* navigation-positioning satellite network is partly intended to eliminate dependence on the U.S. GPS for guidance.

Beijing has purchased foreign systems and assistance to complement its own indigenous LACM efforts. From Israel, it has received Harpy antiradiation drones with standoff ranges of 400+ km. It is conceivable that China may also have the Russian Klub 3M-14E SS-NX-30 LACM, which can be launched from the PLAN's Project 636M *Kilo*-class submarines and deliver a 400-kg warhead to a range of 300 km. But there is little evidence at present to support this possibility.

While current DH-10 ground-launch cruise missiles and YJ-63/AKD-63 air-launched systems are most relevant for a Taiwan contingency, there are strong signs that China is expanding its inventory to include both air-launched and ship-launched LACMs. An air-launched version of the DH-10, called the CJ-20, has reportedly been tested on the H-6 bomber, which has the capability to carry four CJ-20 LACMs externally.

China's Weapon Test Ship *Dahua* 892 has experimented with on-deck canister launchers that contain either YJ-18 ASCMs or DH-10 LACMs for at-sea testing.¹³ Although most PLAN surface combatants have a limited capacity of 8 to 16 canister launchers—meaning tradeoffs between ASCMs and LACMs—China's apparent interest in a sea-launched DH-10 strongly suggests that future PLAN destroyers, such as the new Type 052D, will likely be equipped with a new vertical launching system, with a greater capacity to carry both ASCMs and LACMs.

Should China add large numbers of air- and sea-launched LACMs to its already substantial inventory of ground-launched cruise missiles, it would significantly extend the range of the PLA's capacity to employ LACMs to deal with contingencies beyond Taiwan and the rest of its immediate maritime periphery.¹⁴ Time and dedicated effort will increase the PLA's ability to employ LACMs, even in challenging combined-arms military campaigns.

Cruise Missile Platforms

A given type of cruise missile can typically be launched from many different

platforms. Over the past decade, the PLA has commissioned numerous new, modernized ships, submarines, and aircraft capable of launching cruise missiles. China has produced a new array of frigates and destroyers that carry sophisticated medium- to long-range ASCMs, and some PLAAF/PLAN aviation aircraft can carry LACMs in addition to ASCMs. *Song*-, *Kilo*-, and *Yuan*-class diesel submarines are equipped with Russian and indigenous ASCMs. *Shang*-class nuclear-powered submarines have or will have ASCMs, as will their Type 095 follow-ons when they enter service.¹⁵ China thus appears to be making a concerted effort to develop its delivery capabilities from air, surface, and subsurface platforms simultaneously. In the near term, China will likely continue to expand its cruise missile inventory and precision delivery capabilities.

Cruise Missile Employment, Doctrine, and Training

China's new ASCM and LACM programs—like its current military modernization efforts more broadly—are focused on preparing for contingencies in the Taiwan Strait and other proximate disputed areas, which clearly include the possibility of U.S. intervention. The land, sea, and air components of such a contingency would involve ASCMs and LACMs. China appears to believe in the value of large-scale attacks in all three domains.

Since President Bill Clinton's decision to deploy two aircraft carriers to waters near Taiwan in response to China's March 1996 ballistic missile tests, PLA planners have focused on U.S. aircraft carriers as the main threat to the success of such PLA missions. Chinese strategists have thus sought ways to target U.S. carrier strike groups (CSGs); Chinese specialists are acutely aware of carrier vulnerabilities, having conducted a wide variety of research directed toward threatening aircraft carriers with "trump cards" such as cruise missiles. *Aegis* ships are also viewed as essential targets; without their protection, carriers are much more vulnerable to attack.

Various Chinese writings and the logical employment of forces China has been developing suggest that in the event of a maritime conflict with U.S. forces, the PLAN is likely to undertake massive multi-axis ASCM attacks against U.S. CSGs and their *Aegis* air defense perimeters. The PLAN's focused experimentation and training in long-range sea strike, its variety of indigenous ASCM weapons, and modernization of ASCM delivery platforms may yield a high probability of success for this effort.

Potential Employment in a Taiwan Scenario

Chinese ASCMs and LACMs could be used in conjunction with other A2/AD capabilities to attack U.S. and partners' naval forces, land bases, and sea bases that would be critical for U.S. efforts to respond to a Chinese attack on Taiwan. While cross-Strait relations are relatively stable at present, Beijing worries that that could change, and in any case wants to achieve reunification in peacetime, supported in part by its increasing military advantage over Taiwan.

Operating in tandem with China's huge inventory of conventionally armed ballistic missiles, LACMs could severely complicate Taiwan's capacity to use its air force to defend against Chinese attacks. Chinese military planners view LACMs as particularly effective against targets requiring precision accuracy (for example, airfield hangars and command and control facilities). They also view large-salvo attacks by LACMs and ballistic missiles as the best means to overwhelm enemy missile defenses.

Chinese planners emphasize the shock and paralytic effects of combined ballistic and LACM attacks against enemy airbases, which could greatly increase the effectiveness of follow-on aircraft strikes. These effects depend significantly on the number of launchers available to deliver missiles. China currently has between 255 and 305 ballistic missile and LACM launchers within range of Taiwan, which are capable of delivering sustained pulses of firepower against a number of critical airfields, missile defense sites, early warning radars, command and control



JH-7A fighter-bomber carrying KD-88 land-attack cruise missiles and drop tanks (Courtesy Sino Defense)

facilities, logistical storage sites, and critical civilian infrastructure such as electrical distribution.¹⁶

Proliferation Implications

If China's past record of proliferating ballistic missiles and technology is any indication of its intentions vis-à-vis cruise missile transfers, the consequences could be highly disruptive for the nonproliferation regime and in spreading A2/AD capabilities. China has sold ASCMs to other countries, including Iran. Beijing is suspected of furnishing Pakistan with either complete LACMs or components for local assembly.

China is not a full member of the 34-nation Missile Technology Control Regime (MTCR) but has pledged to adhere to the MTCR's guidelines for missile and missile technology exports. Beijing began seeking MTCR membership in 2004 but has thus far been denied due to concerns about its poor proliferation record. The reason why China represents a critical wildcard regarding the further spread of cruise missiles is that Beijing's current compliance with its pledge to

follow MTCR guidelines is problematic, especially regarding cruise missiles and unmanned aerial vehicles. China needs not only to improve its commitment to address shortcomings in implementation and enforcement but also to work with exporters on improving their compliance with export control regulations and increase its own governmental capacity to deal with the explosive growth of exporting industries across China's huge landmass. This would require significant efforts on China's part. However, if China becomes a fully compliant MTCR member, it would be an important achievement in limiting widespread LACM proliferation.

Conclusion

China has invested considerable resources both in acquiring foreign cruise missiles and technology and in developing its own indigenous cruise missile design and production capabilities. These efforts are bearing fruit in the form of relatively advanced ASCMs and LACMs deployed on a wide range of older and modern air, ground, surface-ship, and subsurface platforms.

To realize the full benefits, China will need additional investments in all the relevant enabling technologies and systems required to optimize cruise missile performance. Shortcomings remain in intelligence support, command and control, platform stealth and survivability, and post-attack damage assessment, all of which are critical to mission effectiveness. To employ cruise missiles to maximum effect, the PLA needs to be able to locate targets at a distance, to deploy its air, surface, and submarine platforms within range of those targets, and then to execute a complex, carefully orchestrated joint air and missile campaign—potentially over many days. Operational success also requires accurate, near-real-time intelligence and post-attack assessment capabilities.

A successful campaign depends on both human and technical factors—extremely well-trained military personnel who have practiced these routines in diverse ways over many years and the command and control architecture needed to deal with complex combined-arms operations. Chinese planners envision establishing a Firepower

Coordination Center within the Joint Theater Command, which would manage the application of air and missile firepower. Separate coordination cells would be created to deal with missile strikes, airstrikes, special operations, and ground and naval forces. Absolutely critical to achieving the delicate timing separating waves of missile strikes designed to leverage the effectiveness of subsequent aircraft attacks is developing the skill to coordinate and deconflict large salvos of missiles and waves of aircraft operating in multiple sectors. Chinese doctrine calls for such attacks, but the PLA's ability to execute such a complex joint campaign against a capable adversary has never been demonstrated.

The future development of China's cruise missile systems will depend on multiple factors. One is the role of ASCMs/LACMs in Chinese defense doctrines and military campaign strategies and their relative cost-effectiveness compared to other weapons systems. Second, cruise missile development, and indeed China's overall defense modernization, will be determined by the government's priorities as Beijing assesses its economic, social, and defense needs against the security environment and real and perceived threats. Third, U.S. military developments, including missile defenses, its own deployment and use of offensive weapons, and its intentions, will influence how China will react and thus the role of cruise missiles within PLA doctrine and force structure. Finally, the capabilities of China's defense industry will continue to be a critical factor in whether Chinese cruise missiles can continue to develop and close the technical gap with other major powers such as the United States and Russia.

ASCMs and LACMs have significantly improved PLA combat capabilities and are key components in Chinese efforts to develop A2/AD capabilities that increase the costs and risks for U.S. forces operating near China, including in a Taiwan contingency. Effective ASCMs give the PLAN an expeditionary capability and the ability to deploy and take on other navies. LACMs give China new conventional strike options. These

apply most to Taiwan, where ground-, air-, and sea-based systems could be employed, but some Chinese LACMs also have the range to reach Japan and the U.S. territory of Guam and will provide a limited capability wherever the PLAN can deploy. China plans to employ cruise missiles in ways that exploit synergies with other strike systems, including using cruise missiles to degrade air defenses and command and control facilities to enable follow-on airstrikes.

Defenses and other responses to PRC cruise missile capabilities exist, but they require greater attention and a more focused effort. They include the development of more effective missile defenses, technical countermeasures, and creative operational responses. Missile defenses against large-volume Chinese LACM threats will need special attention, if the poor U.S. performance against Iraq's primitive and small number of LACMs in Operation *Iraqi Freedom* is an indicator of U.S. weaknesses vis-à-vis such threats. JFQ

Notes

¹ To be sure, the combination of all three of these aspects is difficult to achieve. A supersonic missile is usually not stealthy, particularly from an infrared perspective, and such missiles tend to fly higher to get decent engagement ranges. To delay detection and thereby reduce reaction time, subsonic missiles typically use low-altitude flight profiles. Combining all of them into one missile is difficult to do, and China currently lacks a missile with all three of these characteristics. Information presented by Christopher P. Carlson at the Workshop on Open Source Exploitation, sponsored by Naval War College and Potomac Foundation, Vienna, VA, March 3, 2014.

² A good synopsis of Chinese antiship cruise missiles (ASCM) development can be found in Wang Wei, "Development of the PLA-Navy's Anti-ship Missile," *Shipborne Weapons* 5 (May 2008), 35–47.

³ For instance, the HY-2/4 ASCMs have been exported as the C-201/201W.

⁴ This series is essentially defunct, having not competed well with the export versions of the HY and YJ series.

⁵ *Russia's Arms and Technologies: The XXI Century Encyclopedia—Naval Weapons*, Volume III (Moscow: Arms and Technologies Publishing House, 2001); Machine Building Design Bureau marketing brochure—3M80E antiship attack missile-weapon complex. For 3M80MVE

characteristics, see the Tactical Missiles Corporation JSC Web site at <http://eng.ktrv.ru/production_eng/323/507/541/?PHPSESSID=b56ca0fa59423f9a752a0ccdc67eb72a>.

⁶ Christopher P. Carlson, "China's Eagle Strike—Eight Anti-Ship Cruise Missiles: YJ-81, YJ-81, and C802 (Part 2)," Defense Media Network, February 6, 2013, available at <www.defensemedianetwork.com/stories/chinas-eagle-strike-eight-anti-ship-cruise-missiles-yj-81-yj-82-and-c802/>.

⁷ Ibid.

⁸ "C602: Anti-Ship Missile Weapon System," China National Precision Machinery Import and Export Corporation marketing brochure, 2010.

⁹ Christopher P. Carlson, "YJ-12 Photographic Analysis," February 2014; "Chinese YJ-12 Supersonic Anti-Ship Missile Revealed," *Chinese Military Review*, January 2013, available at <<http://chinesemilitaryreview.blogspot.com/2013/01/chinese-yj-12-supersonic-anti-ship.html>>.

¹⁰ Christopher P. Carlson, "Deciphering the Eagle Strike-8 Family of Anti-Ship Cruise Missiles," presentation at Workshop on Open Source Exploitation.

¹¹ "PLA's Tactical Air-To-Surface Missiles (Part 1)," *SinoDefence*, February 18, 2014, available at <<http://sinodefence.com/2014/02/18/plas-tactical-air-to-surface-missiles-part-1/>>.

¹² Pan Wenlin, "Small Gas-Turbine Unit and China's Antiship Cruise Missiles," *Shipborne Weapons* 8 (August 2010), 14–25; "KD-63 (YJ-63), K/AKD-63," *Jane's Air-Launched Weapons*, January 28, 2014, available at <www.janes.com>.

¹³ "Navalized DH-10 LACM," *China Defense Blog*, July 25, 2012, available at <<http://china-defense.blogspot.com/2012/07/navalized-cj-10-lacm.html>>.

¹⁴ James C. Bussert, "China Destroyer Consolidates Innovations, Other Ship Advances," *Signal*, December 1, 2013, available at <www.afcea.org/content/?q=node/11972>.

¹⁵ *Military and Security Developments Involving the People's Republic of China 2013*, Annual Report to Congress (Washington, DC: Office of the Secretary of Defense, 2013), 4, available at <www.defense.gov/pubs/2013_china_report_final.pdf>.

¹⁶ *Military and Security Developments Involving the People's Republic of China 2009*, available at <www.defense.gov/pubs/pdfs/China_Military_Power_Report_2009.pdf>. Figures were derived from the chart on page 66 of the 2009 report. Only CSS-6 and CSS-7 missile launchers and DH-10s were considered. As the most important factor in delivering pulses of power, missile launchers (not missiles) were the focus. Like aircraft launched from carriers, missiles launched are the appropriate measure of the intensity of fire within a unit of time.